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# Socio-Economic Impacts of Climate Change on North East India: A Comprehensive Review

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***Abstract***

*The North East region of India, comprising the states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, and Sikkim, is highly vulnerable to climate change due to its unique geographical features, biodiversity, and socio-economic constraints. This review paper examines the effects of climate change on the socio-economic status of the North East Indian population, focusing on agriculture, water resources, health, and infrastructure. The literature indicates significant alterations in temperature and precipitation patterns, leading to extreme weather events such as floods and droughts, which severely impact agricultural productivity, water availability, and health outcomes. The region's adaptive capacity is limited by socio-economic factors and inadequate infrastructure, despite the presence of governmental policy frameworks like the National Action Plan on Climate Change (NAPCC) and State Action Plans on Climate Change (SAPCC). This review aims to assess the specific areas most affected by climate change, evaluate current adaptive measures, and provide recommendations for enhancing resilience and adaptive capacity. The findings underscore the need for a comprehensive approach involving effective policy implementation, community engagement, and improved access to technology and financial resources to mitigate the socio-economic challenges posed by climate change and promote sustainable development in the region.*

***Keywords:*** *Climate change, North East India, socio-economic impacts, agriculture and water resources, adaptive capacity and resilience*

## Introduction

The North East region of India, encompassing the states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, and Sikkim, is a distinctive ecological and cultural zone. This area is renowned for its rich biodiversity and significant ethnic diversity, hosting numerous indigenous communities with unique languages, traditions, and cultural practices (Sharma and Bora, 2019). The region's vast ecological wealth includes diverse ecosystems, from tropical rainforests and wetlands to high-altitude Himalayan habitats, making it one of the most ecologically sensitive and diverse regions in the country (Tripathi et al., 2020). The geographical characteristics of the North East, marked by its mountainous terrain, extensive river systems, and high forest cover, contribute to its ecological significance but also to its vulnerability to climate change. The region's climate is influenced by the Indian monsoon system, with substantial seasonal rainfall, which is critical for agriculture – the mainstay of the local economy. However, this dependence on climate-sensitive agriculture exacerbates the region's susceptibility to climatic changes (Singh & Singh, 2018).

Climate change has begun to manifest in the North East through alterations in temperature and precipitation patterns, leading to increased frequency and intensity of

extreme weather events such as floods, droughts, and landslides. These environmental changes pose severe threats to the socio-economic status of the region's population. For instance, unpredictable monsoon rains and extended dry periods adversely affect agricultural productivity, threatening food security and the livelihoods of farmers who constitute a significant portion of the population (Choudhury and Das, 2021). Additionally, the region's socio-economic constraints, such as limited infrastructure, inadequate healthcare, and financial limitations, further compound the impacts of climate change, making adaptive responses more challenging (Mishra et al., 2020).

Research indicates that climate change has significant implications for water resources, health, and infrastructure in the North East. The melting of Himalayan glaciers affects river flow patterns, leading to water scarcity during dry periods and exacerbating flood risks during the monsoon season (Goswami and Ranjan, 2019). Health outcomes are also impacted, with increased incidences of vector-borne diseases such as malaria and dengue, driven by changing temperature and humidity levels (Baruah et al., 2020). Moreover, frequent natural disasters like floods and landslides cause extensive damage to infrastructure, including roads, bridges, and homes, imposing heavy economic costs on both the government and local communities (Das and Ghosh, 2019). Given these challenges, there is an urgent need to explore adaptive measures that can mitigate the socio-economic impacts of climate change in the North East. This review paper aims to comprehensively examine the effects of climate change on the socio-economic status of the North East Indian population. It will analyse the impacts on key sectors such as agriculture, water resources, health, and infrastructure, and discuss potential adaptive strategies and policy measures. The objective is to contribute to the development of sustainable solutions that enhance resilience and promote socio-economic well-being in this vulnerable region (Roy and Singh, 2018). By synthesizing existing research and policy frameworks, this paper seeks to provide a detailed understanding of the multifaceted impacts of climate change on the North East and to offer practical recommendations for building adaptive capacity and resilience in the region.

## Literature Review

### Climate Change and Environmental Impacts:

Climate change has emerged as a significant driver of environmental change in the North East region of India, leading to substantial alterations in temperature and precipitation patterns. The Intergovernmental Panel on Climate Change (IPCC) (2019) reports a notable rise in average temperatures and shifts in monsoon patterns in the region. These changes have precipitated extreme weather events such as floods and droughts, significantly impacting both the natural environment and human livelihoods. Ahmed and Mehta (2020) highlight a concerning trend of increasing frequency and intensity of floods in Assam over recent decades. These floods have had severe repercussions on agricultural activities, displacing thousands of people annually and disrupting local economies. Furthermore, studies by the National Institute of Disaster Management (NIDM) (2020) underscore the heightened occurrence of landslides and droughts in the region. These events not only result in immediate destruction but also inflict long-term damage on the environment and livelihoods.

Das and Goswami (2019) provide empirical evidence of the profound impact of recurrent floods in Assam and Meghalaya on local communities. They document instances of soil erosion, loss of arable land, and destruction of critical infrastructure, exacerbating the vulnerability of populations already grappling with climate-induced challenges. These

findings highlight the urgent need for comprehensive mitigation and adaptation strategies to address the escalating environmental impacts of climate change in the North East region of India.

**Socio-Economic Impacts:**

Climate change significantly impacts various aspects of the socio-economic status of the North East population, with agriculture bearing a substantial brunt of the consequences. As the primary livelihood for the majority of the region's inhabitants, agriculture is highly susceptible to climate variability. Fluctuations in precipitation and temperature, as documented by the Ministry of Environment, Forest and Climate Change (MoEFCC) (2018), have detrimentally affected crop yields, particularly for staple crops such as rice and tea. Bhuyan and Borthakur (2017) further corroborate this, noting that unpredictable weather patterns have resulted in reduced agricultural productivity, exacerbating food insecurity and poverty among farmers. These findings underscore the vulnerability of agricultural communities in the face of climate change-induced challenges. In addition to its impacts on agriculture, climate change has severe health implications for the North East population. The World Health Organization (WHO) (2019) has documented a rise in vector-borne diseases, including malaria and dengue, attributed to increasing temperatures and changing rainfall patterns. Baruah et al. (2020) highlight the heightened vulnerability of low-lying areas in Assam, where stagnant water from frequent flooding creates conducive breeding grounds for disease-carrying mosquitoes. This surge in health problems imposes additional strain on the region's already limited healthcare infrastructure, exacerbating the challenges posed by climate change. Addressing these intertwined socio-economic and health impacts necessitate robust mitigation and adaptation measures tailored to the unique context of the North East region of India.

**Adaptive Capacity and Policy Measures:**

The adaptive capacity of the North East region is intricately tied to socio-economic factors and the state of infrastructure. While the Government of India has established policy frameworks such as the National Action Plan on Climate Change (NAPCC) (2018) and State Action Plans on Climate Change (SAPCC) (2019) to enhance resilience and adaptive capacity, their implementation encounters significant challenges. Sharma and Bora (2018) underscore that despite the well-intentioned nature of these policies, their execution is impeded by constraints such as limited financial resources, technical expertise, and ineffective local governance structures. These limitations hinder the region's ability to effectively respond to the impacts of climate change. However, community-based adaptation strategies offer promise in bolstering resilience within the North East region. Localized efforts in Assam and Nagaland, leveraging traditional knowledge and practices in agriculture and water management, have demonstrated positive outcomes. Roy et al. (2019) advocate for greater support and integration of these initiatives with broader policy measures to ensure their sustainability and effectiveness. Furthermore, Choudhury and Das (2019) stress the imperative of robust infrastructural development, including improved flood management systems and healthcare facilities, to augment the region's adaptive capacity.

The literature underscores the profound environmental and socio-economic impacts of climate change on the North East region of India. Given its heavy reliance on climate-sensitive sectors like agriculture and existing socio-economic constraints, the region is particularly vulnerable. While policy frameworks like the NAPCC and SAPCC lay the

groundwork for resilience-building efforts, effective implementation and community involvement are essential to comprehensively address the challenges posed by climate change in the region.

## Objectives

This review aims to thoroughly investigate the multifaceted impacts of climate change on the socio-economic landscape of the North East Indian population, focusing on identifying key areas for intervention and enhancement. The primary objective is to meticulously evaluate the impact of climate change on various socio-economic indicators, including livelihoods, agriculture, health, and infrastructure. Additionally, the review seeks to pinpoint specific geographical areas within the North East region that are most severely affected by climate change to devise targeted interventions and adaptation strategies effectively. Furthermore, it aims to critically evaluate the effectiveness of existing adaptive measures and policies implemented by governmental and non-governmental entities, providing insights into areas requiring improvement. Building upon the assessment and evaluation, the review endeavors to formulate actionable recommendations for enhancing resilience and adaptive capacity in the region, informed by best practices gleaned from the literature.

## Research Methodology

To achieve these objectives, this review paper adopts a robust and comprehensive methodology. It employs a systematic literature review approach, encompassing both primary and secondary sources. Primary sources include authoritative government reports, peer-reviewed research papers, and publications from reputable international organizations such as the Intergovernmental Panel on Climate Change (IPCC) and the World Health Organization (WHO). Data collection is conducted through meticulous search and retrieval from online databases such as Google Scholar, PubMed, and institutional repositories, ensuring the inclusion of relevant and credible literature. Only studies meeting predefined inclusion criteria, such as relevance, credibility, and currency, are considered for inclusion in the review. Data obtained from the literature review are subjected to rigorous analysis, involving categorization, synthesis, and interpretation of findings, enabling the identification of key themes, trends, and insights pertaining to the objectives of the review. Through this meticulous methodology, the review paper endeavours to provide a comprehensive understanding of the impacts of climate change on the socio-economic status of the North East Indian population and offer actionable recommendations for enhancing resilience and adaptive capacity in the region.

## Analysis and Results

### Impact on Agriculture:

Climate change continues to impose profound disruptions on agricultural productivity in the North East region, a critical issue substantiated by recent research findings. Ahmed and Mehta (2020) offer compelling evidence of how altered rainfall patterns and escalating temperatures have detrimentally affected crop yields, particularly staples like rice. Their study reveals a discernible decline in agricultural productivity directly linked to these climatic shifts, posing a serious threat to food security across the region. Recent research by Roy et al. (2021) further supports these findings by highlighting the increasing frequency and intensity of extreme weather events, such as cyclones and erratic rainfall, exacerbating agricultural

challenges and amplifying the urgency for adaptive strategies. Further reinforcing these insights, Bhuyan and Borthakur (2017) emphasize the consequential relationship between diminishing agricultural output and heightened poverty levels within farming communities. Their study illustrates how climate-induced disruptions exacerbate socio-economic vulnerabilities, creating a cyclical pattern of food insecurity and economic instability. Recent findings by Sharma and Baruah (2022) shed light on the disproportionate impact of climate change on marginalized farming communities, underscoring the need for equitable adaptation measures to address underlying vulnerabilities effectively.

The recent studies emphasise the critical impact of climate change on agriculture in the North East region of India, emphasizing the urgent need for robust mitigation and adaptation measures. Addressing these challenges effectively is crucial not only for safeguarding food security but also for promoting sustainable socio-economic development in the region. Through proactive interventions and collaborative efforts, stakeholders can work towards building resilient agricultural systems capable of withstanding the impacts of climate change while fostering inclusive growth and development.

**Water Resources:**

Recent research has further elucidated the profound impacts of climate change-induced alterations in precipitation patterns and Himalayan glacier melt on water availability in the North East region. Das and Goswami (2019) provide compelling evidence regarding the variable flow patterns of the Brahmaputra River, a crucial water source in the area. Their study reveals the complex interplay of floods and water shortages, posing significant challenges for irrigation and agricultural practices. Additionally, recent findings by Roy et al. (2021) emphasize the increasing variability in monsoon rainfall and its implications for water availability, exacerbating the socio-economic vulnerabilities of communities reliant on agriculture. The recent studies also noted the broader ramifications of these water resource challenges on daily life in the North East region. Changes in water availability disrupt various aspects of daily life, including domestic water usage and industrial processes, as highlighted by Baruah et al. (2022). This underscores the urgent need for holistic water resource management strategies that integrate climate-induced variability and prioritize community resilience. By adopting proactive measures such as community-based water management initiatives and resilient infrastructure design, stakeholders can effectively mitigate the socio-economic impacts of water resource fluctuations and foster sustainable development in the North East region.

**Health Impacts:**

Recent findings by Baruah et al. (2020) have provided further insights into the health consequences of climatic changes in the North East region, particularly regarding the proliferation of vector-borne diseases. Their research underscores the escalating threat posed by diseases like malaria and dengue, with rising temperatures and humidity levels creating conducive environments for disease vectors. Additionally, recent studies have delved into the compounding impact of climate change-induced floods and extreme weather events on the prevalence of waterborne diseases and injuries. Research conducted by Roy et al. (2018) highlights how these events exacerbate health risks, placing additional strain on the region's already overburdened healthcare infrastructure. Recent studies highlighted the disproportionate burden of these health challenges on marginalized communities lacking access to adequate healthcare services. Research by Sharma and Das (2021) emphasizes the

widening socio-economic disparities exacerbated by climate-induced health impacts, necessitating targeted interventions to promote health equity. Addressing these challenges requires comprehensive strategies that integrate climate resilience into healthcare systems and prioritize equitable access to healthcare services. By adopting a holistic approach that considers the intersectionality of climate change and health, stakeholders can effectively mitigate health risks and promote the overall well-being of communities in the North East region.

**Infrastructure and Housing:**

The recent studies, including those by Das and Goswami (2019), have highlighted the evolving nature of natural disasters in the North East region and their increasingly severe impacts on infrastructure and housing. These findings have elucidated a growing trend of heightened vulnerability to floods and landslides, exacerbated by changing climate patterns. The research by Das and Goswami has delved into the nuanced socio-economic consequences of these events, shedding light on the escalating financial burdens faced by governmental bodies and local communities alike in the aftermath of natural disasters. Moreover, recent studies have underscored the necessity for proactive approaches to disaster preparedness and infrastructure resilience. Research conducted by Sharma et al. (2021) emphasizes the effectiveness of early warning systems in reducing the loss of life and property damage during natural calamities. Additionally, studies by Roy and Dutta (2018) have elucidated the pivotal role of community-based disaster management initiatives in bolstering the region's capacity to cope with and recover from such adversities. These insights collectively underscore the critical importance of integrating climate resilience considerations into infrastructure planning and development endeavours, thereby ensuring the long-term sustainability and well-being of communities in the North East region.

In light of these recent findings, stakeholders are urged to prioritize collaborative action and investment in disaster risk reduction measures. By fostering partnerships among governmental agencies, local communities, and relevant stakeholders, it becomes feasible to effectively mitigate the adverse impacts of climate change-induced natural disasters while concurrently advancing resilience and sustainable development objectives in the region.

## Discussion

The socio-economic impacts of climate change in North East India present a multifaceted challenge, with agriculture emerging as a particularly vulnerable sector due to the region's heavy reliance on it. The decline in agricultural productivity, exacerbated by altered rainfall patterns and rising temperatures, not only threatens food security but also deepens poverty levels. Additionally, the strain on water resources and health infrastructure underscores the pressing need for adaptive measures to mitigate these impacts. Despite the presence of government policies such as the NAPCC and SAPCC aimed at addressing climate change, their effectiveness is hampered by resource constraints and governance challenges. Community-based adaptation strategies, while promising in leveraging local knowledge and participation, require greater support and integration with broader policy measures to enhance resilience effectively. The recent studies discussed in this review shed light on the multifaceted impacts of climate change on agriculture in the North East region. Ahmed and Mehta (2020) and Roy et al. (2021) provide compelling evidence of the adverse effects of altered rainfall patterns and rising temperatures on crop yields, emphasizing the urgent need for adaptive strategies. Bhuyan and Borthakur (2017) and Sharma and Baruah

(2022) further highlight the socio-economic vulnerabilities exacerbated by climate-induced disruptions, stressing the importance of targeted interventions to bolster agricultural resilience.

Research also elucidates the profound impacts of climate change-induced alterations in precipitation patterns and Himalayan glacier melt on water availability in the North East region. Das and Goswami (2019) and Roy et al. (2021) illustrate the challenges posed for irrigation and agricultural practices, emphasizing the need for holistic water resource management strategies. Baruah et al. (2022) underscore the broader ramifications of water resource challenges on daily life, advocating for strategies that prioritize community resilience. Baruah et al. (2020) provide insights into the health consequences of climatic changes in the region, highlighting the proliferation of vector-borne diseases. Recent studies delve into the compounding impact of climate change-induced floods and extreme weather events on health, emphasizing the disproportionate burden on marginalized communities. Infrastructure and housing face severe impacts from natural disasters, with studies by Das and Goswami (2019) and Sharma et al. (2021) emphasizing the need for integrated climate resilience considerations in planning and development efforts.

## Conclusion

Climate change presents significant socio-economic challenges to the population of North East India, exacerbating vulnerabilities due to its reliance on climate-sensitive sectors and limited adaptive capacity. Tackling these challenges necessitates a comprehensive approach encompassing effective policy implementation, community engagement, and access to technology and financial resources. Strengthening the region's resilience to climate change is imperative for achieving sustainable development and enhancing the socio-economic well-being of its inhabitants. Recent research emphasise the critical and multifaceted impacts of climate change on various facets of life in North East India. Agriculture, a vital component of the region's economy, confronts substantial hurdles stemming from altered rainfall patterns and escalating temperatures. These factors contribute to diminishing crop yields, exacerbating food insecurity, and deepening poverty levels. Moreover, the strain on water resources and health infrastructure exacerbates these challenges, underscoring the urgent need for adaptive measures. While governmental policies like the NAPCC and SAPCC provide a framework for addressing climate change, their efficacy is hampered by resource constraints and governance issues. Community-based adaptation strategies offer promise in bolstering resilience but require greater support and integration with broader policy measures to yield optimal results.

Studies examining agriculture, water resources, health impacts, and infrastructure and housing collectively emphasize the necessity for holistic approaches to climate change adaptation and mitigation. Implementing robust measures for both mitigation and adaptation is crucial not only for safeguarding food security and public health but also for fostering sustainable socio-economic development in the region. Given these findings, stakeholders are encouraged to prioritize collaborative action and investment in disaster risk reduction measures. By fostering partnerships among governmental agencies, local communities, and pertinent stakeholders, it becomes possible to effectively mitigate the adverse impacts of climate change-induced natural disasters while concurrently advancing resilience and sustainable development goals in the North East region.

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